CALCULATIONS FOR:

Waterbury, VT IM 089-2(43)
506.55, Structural Steel, Plate Girder
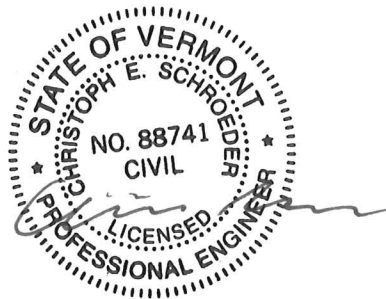
Steel Handling and Erection Plan

July 7, 2016
Amended July 11, for girder E changes
Amended July 14, per VTrans comments

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7-14-2016

Design References:
  NHDOT Standard Specifications, Section 550 (for girder stability)
  LRFD Steel Design, 2nd Ed., by William T. Segui
  LRFD Design Manual, by the AISC

Plans and Specifications:
  VTrans Contract Drawings
  ARC Steel Shop Drawings

Description of Work:
  The bridge is multiple spans. Provide temporary lateral support for the first girder line placed while placing the second girder line. Set the first two girder sections across all girder lines before proceeding to the next two girder sections. The permanent diaphragms are used during erection, to provide lateral support for subsequent girders. After all girders are erected, the bolts will be torqued and inspected.

Equipment Used:
  Link-Belt 138 HSL
  Link-Belt RTC 80110
  Link-Belt ATC 3210
  Link-Belt RTC 8050 (helper crane for temporary girder support)

Check girder stability:
 From NHDOT spec:

> 3.14.2.4   Lifting. Proper consideration shall be given to guard against lateral buckling when lifting beams and girders. Generally speaking, straight beams and girders 30 in. (760 mm) in depth or deeper, lifted according to the following criteria should be stable. Dimensions for length/width ratios are in feet and b equals the minimum width of the flange in compression.
>
>   (a)   One Crane (Overhang using a single line pickup at the girder centerline with or without a spreader) – For the unsupported overhang length, d, the maximum d/b ratio should not exceed 35 nor should the overhang length exceed 50 ft.
>   (b)   Two Cranes (Distance between beam clamps at the girder ends on a two-point pick-up) – For the unsupported length, a, between beam clamps on a two-point pickup, the a/b ratio should not exceed 85 nor should the distance between pickup points exceed 100 feet.

The girders must be kept stable while lifting, so the NHDOT standard specification 550.3.14.2.4, for lifting of steel girders, will be used to check the girder pick points.

Max interior support: a/b < 85; a_{max} = 85*1.33' = 113', use 100'. **100' max interior support spacing.**

Girder A:
Flange width b = 16" = 1.33' (note: use 25-ton beam clamps for 16"-24" wide flange.)
Max overhang: d/b < 35; d_{max} = 35*1.33' = 46'. Girder length is 82' / 2 = 41' overhang if picked in the middle. 41' < 46', **ok for 1 pick point**.

Girder B:
Flange width b = 20" = 1.66' (note: use 25-ton beam clamps for 16"-24" wide flange.)

Max overhang: $d/b < 35$; $d_{max} = 35*1.66' = 58'$, use 50' max. Girder length is 89' / 2 = 45' overhang if picked in the middle. 45' < 50', **ok for 1 pick point**.

Girder C:
Flange width $b = 16" = 1.33'$ (note: use 25-ton beam clamps for 16"-24" wide flange.)
Max overhang: $d/b < 35$; $d_{max} = 35*1.33' = 46'$. Girder length is 108' / 2 = 54' overhang if picked in the middle. N.G. – need spreader beam.
108' – 46'*2 = 16', need **16' min spreader beam with 31 k = 16 ton capacity.**

Girder D:
Flange width $b = 20" = 1.66'$ (note: use 25-ton beam clamps for 16"-24" wide flange.)
Max overhang: $d/b < 35$; $d_{max} = 35*1.66' = 58'$, use 50' max. Girder length is 89' / 2 = 45' overhang if picked in the middle. 45' < 50', **ok for 1 pick point**.

Girder E:
Flange width $b = 20" = 1.66'$ (note: use 25-ton beam clamps for 16"-24" wide flange.)
Max overhang: $d/b < 35$; $d_{max} = 35*1.66' = 58'$, use 50' max. Girder length is 70' / 2 = 35' overhang if picked in the middle. 45' < 50', **ok for 1 pick point**.

A note about pick overhangs: I understand it is common construction practice to use the above support distances in combination with additional loading from diaphragms, overhang brackets, etc. Such extra weight is relatively small; for this girder, the self-weight is at least 244 lb/ft, vs. approx. 20 lb/ft for diaphragms and hangers.

Load to Pick:
The weight of the pick is based on a single girder, plus any diaphragms and splice plates, and an allowance for rigging (sufficient to include typical spreader beams and beam clamps).

The steel has the following max. piece weights, from the structural steel drawings:
Diaphragms: 295 lb. ea. Allow for 3 diaphragms on typ girders, 4 on girder C
Splice Plates (max): 125*2 + 65*4 + 150*2 + 30*2 = 870 lb * 1.5 for bolts = 1300 lb at end of A&B girders, and both ends of D girders.
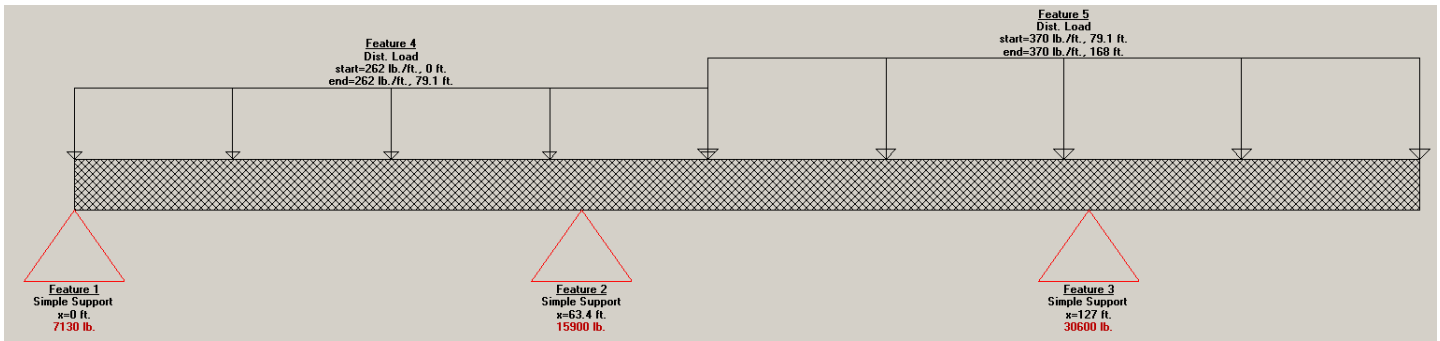Rigging: allow for 2500 lb for block and cable. Girder C has additional 1200 lb for a 20' speader beam

Girder stability with temporary crane supports:
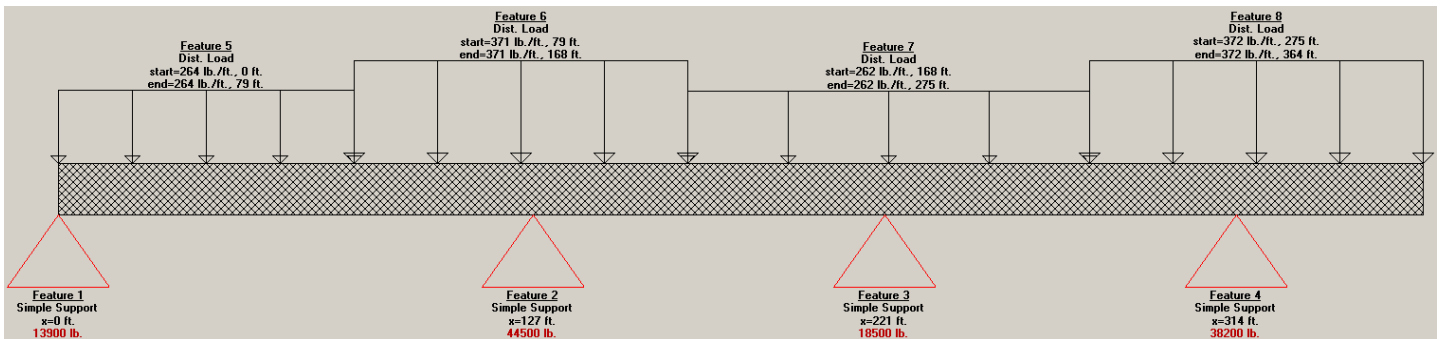50-ton crane is to hold the first girders while the other cranes set the second girder line.

Load on 50-ton crane:
Girders A-B: crane is to lift at midpoint of span 1.

Feature 4
Dist. Load
start=262 lb./ft., 0 ft.
end=262 lb./ft., 79.1 ft.

Feature 5
Dist. Load
start=370 lb./ft., 79.1 ft.
end=370 lb./ft., 168 ft.

Feature 1
Simple Support
x=0 ft.
7130 lb.

Feature 2
Simple Support
x=63.4 ft.
15900 lb.

Feature 3
Simple Support
x=127 ft.
30600 lb.

Support reaction at helper crane = 15.9 k
RTC8050 has capacity = 17.8 k at R = 40', ok radius per drawing.

Girders A-D:

Feature 5
Dist. Load
start=264 lb./ft., 0 ft.
end=264 lb./ft., 79 ft.

Feature 6
Dist. Load
start=371 lb./ft., 79 ft.
end=371 lb./ft., 168 ft.

Feature 7
Dist. Load
start=262 lb./ft., 168 ft.
end=262 lb./ft., 275 ft.

Feature 8
Dist. Load
start=372 lb./ft., 275 ft.
end=372 lb./ft., 364 ft.

Feature 1
Simple Support
x=0 ft.
13900 lb.

Feature 2
Simple Support
x=127 ft.
44500 lb.

Feature 3
Simple Support
x=221 ft.
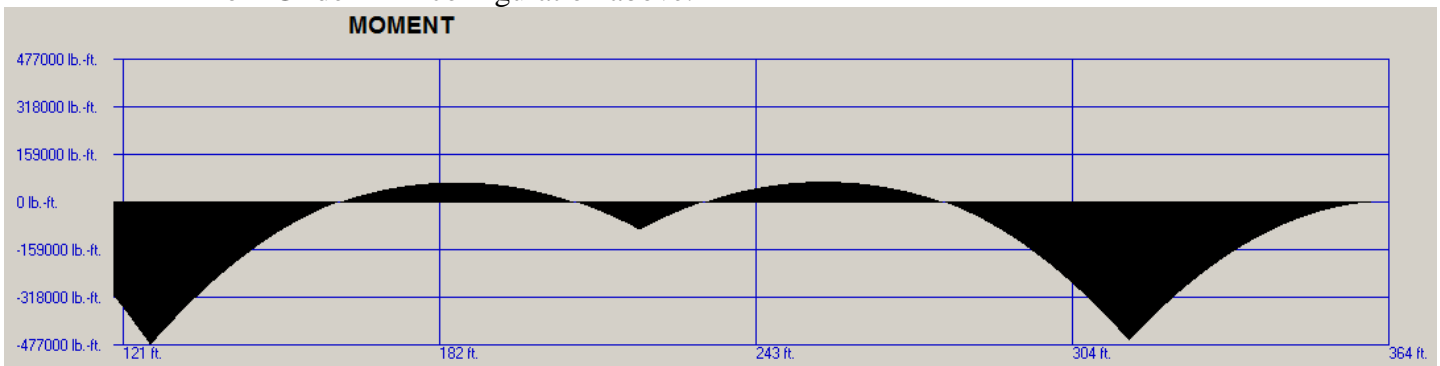18500 lb.

Feature 4
Simple Support
x=314 ft.
38200 lb.

Support reaction at helper crane = 18.5 k
RTC8050 has capacity = 37.9 k at R = 25', ok radius per drawing.

Girder E:
Less unbraced length than girdera A-B. ok by inspection.

Check stability of middle span, with helper crane picking girder. Unbraced length is from last diaphragm on girder section B to pier 2.

From Girder A-D configuration above:

MOMENT

477000 lb.-ft.				
318000 lb.-ft.				
159000 lb.-ft.				
0 lb.-ft.				
-159000 lb.-ft.				
-318000 lb.-ft.				
-477000 lb.-ft.	121 ft.	182 ft.	243 ft.	304 ft. 364 ft.

Lb = 153' = 1836 in from last diaphragm on girder B to pier 2
Unbraced length is comparatively very long vs Lb and Lr; assume elastic LTB. Use section properties for girder C.

$$Mn = Cb*pi()/Lb* sqrt\{ E*Iy*G*J + (pi()*E/Lb)^2 * Iy*Cw \} < Mp$$

Cb	2.99
Lb	1836 in
E	29000 ksi
Iy	598 in^4
G	11200 ksi
J	9.18 in^4
Cw	793000 in^6

$$Mp = Fy * Zx = 50 \text{ ksi} * 1749 \text{ in}^4 = 87450 \text{ k-in}$$

Mn =   8788.448 k-in

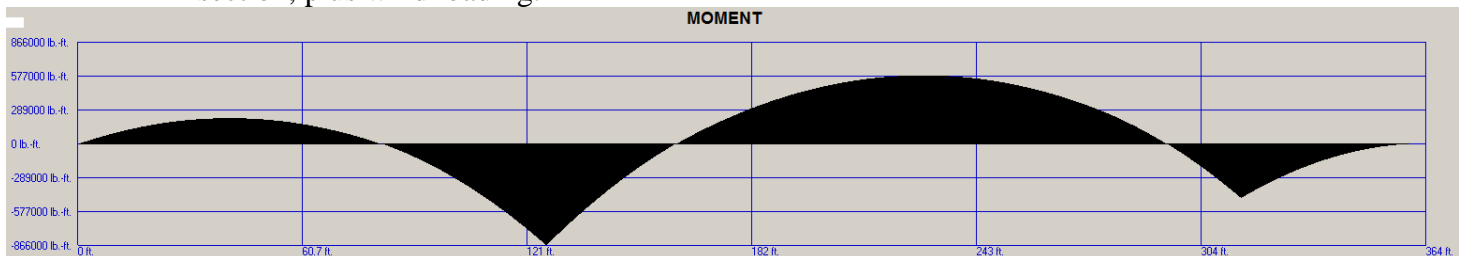   < Mp, use value shown.

Mu =   477 k-ft

                5724 k-in

                0.65 of Mn, ok.

        also, the helper crane will provide some amount of lateral support

Temporary Bracing at Supports for First Girder:

Temporary bracing must resist 2% or the bending moment resisted by half the girder section, plus wind loading.

The max moment while using the helper crane (assume helper crane is absent to maximize moments) is found to be at pier 1 & 2 while girders A-D are connected. Mmax = 866 k-ft = 10,400 k-in.

For a T-section of half the girder, find the centroid (use smallest section):

	A	ybar	A*ybar
1/2 web	20.25	18	364.50
flange	14	36.4375	510.13
sums:	34.25		874.63

Ybar =   25.54 inches from centroid

Compressive load from bending = 10400 k-in / 2 for compressive component / 25.54 in Ybar = 204 k

Brace load = 204 k * 0.02 = 4 k horizontal brace load.

Wind pressure: take as 30 mph. Wind may add to the brace load, say for 40 mph, pressure (psf) = 0.00256*30 mph^2 = 2.3 psf * 6' height * 2.0 for drag on a flat plate = 28 lb/ft / 2 for top flange * 157' max tributary length = 2.2 k horizontal wind force.

Total horizontal brace load = 4 k + 2.2 k = 6.2 k. Total axial brace load for 45-deg brace = 6.2 k / sin(26) = 14 k axial load total. Divide among several braces.

For **1 brace each side of girder,** each brace must support 14 k axial load. By inspection, this force is resisted by min 2 runs of 3/8" cable (SWL = 14,840 lb / 2 = 7.4 k ea) or chains connected to plate hooks at the girder, and tied down to adjacent anchor bolts. Note the bracing material is to have SWL = 14,000 lb.

Worker Protection:
Workers will be allowed on the erected steel only while all girders are braced with diaphragms or temporary bracing as indicated above, or the workers are in manlifts or man baskets. To allow worker access to the steel, fall protection posts and cable will be installed on girders prior to erection. The DBI/Sala Protecta fall protection system requires cable supports every 60' at maximum, so three posts will be used on the 124' girders, and two posts on the 38' girders. After splicing, the fall protection lines will be strung the whole length of the bridge.

Attachments:
Crane Charts
Beam Clamps Information
Fall Protection Posts Information
Steel Erection Plan, sheet 1/1

7-11-16: Girder E changes
Use 80110 to set girder E from below the bridge. 70' radius is ok per drawing.

Eliminate helper crane to support girder E. Unsupported length = 70' girder + 5' to diaphragm on girder D = 75'. Per above, the allowable interior support spacing = 100' > 75, ok.

Check that end of girder D will be above its final position, when girders A-D are in place. This check is to ensure girder splice will be possible without jacking the girders at pier 2.

Deflection at end of girder D = +0.83", positive deflection at end; ok.
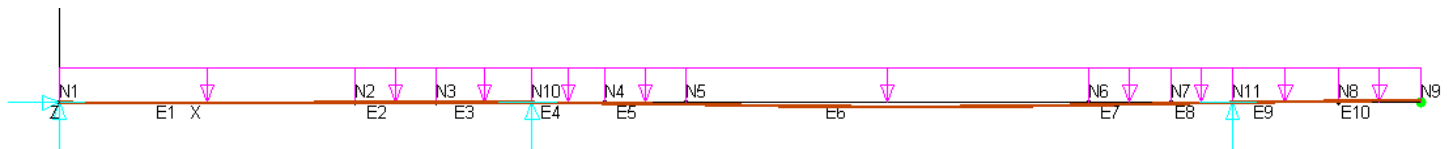
7-13-16: Check girder stability during picks:
Check the longest, skinniest girder (Girder section C) first.

Check girder compactness:
Flange:
    λ = 16"/ 2*0.875" = 9.14
    λ_p = 65/√50 ksi = 9.19 > 9.14, flange is compact.
    λ_r = 141 / √40 ksi = 22
Web:
    λ = 72"/ 9/16" = 128
    λ_p = 640 / √50 ksi = 91
    λ_r = 970 / √50 ksi = 137 > 128 > 91, web is non-compact.

Analysis for slender plate girders (AISC appendix G) is not applicable, as this girder is non-compact, not slender. See below for analysis.

Check for unbraced length = 108' (entire girder), since there are no lateral braces:
The plate girder is: web non-compact (not slender), flange compact.
Flange:
    F_y = 50 ksi

L_b = 108' = 1296"
L_p = 300*ry/√Fy
        ry = 2.95 in
Lp = 300*2.95/√50 = 125"
L_b > L_p, and L_b will be > L_r by inspection, so elastic LTB with non-compact section, and check LTB:
    Mn = Cb*π/Lb * √[E*Iy*G*J + (π*E/Lb)^2 * Iy*Cw] < Mp
            Take Cb = 1.0 since ends are not laterally supported
    Mn = 1.0*π/1296" * √[29,000 ksi * 598.4 in4 * 11,200 ksi * 9.18 in4 +
(π*29,000 ksi/1296")^2 * 598.4 in4 * 79.3E4 in6] = (units 1/in * √(k2 * in4) = k-in)
    Mn = 0.00242 * √[1.783E12 + 70.298^2 * 4.745E8]
    Mn = 4925 k-in;
    Mp = Fy*Zx = 50 ksi * 1749 in3 = 87,450 k-in so use Mn

Applied moment: take girder dead weight and add 0 k at each end for splice cages
(cages N/A on girder C). Lever arm = 1296" / 2 – 20' spreader /2 * 12 = 528"
Load = 26.15 k girder + 0.295 k * 4 diaphragms = 27.33 k / 1296" = 0.021 k/in

Mult = 0.021 k/in DL * 528^2/2 + 0 k * 528" = 2928 k-in, FoS = 4925 / 2928= 1.68,
beam is okay with unsupported compression flange in Lateral-Torsional Bucking.

Check Web local buckling: noncompact

$M_n = M_p - (M_p - M_r) * (\lambda - \lambda_p) / (\lambda_r - \lambda_p) < M_p$

  $M_p = 87{,}450$ k-in (above)
  $M_r = (F_y - F_r) * S_x = 40$ ksi $* 1482$ in3 $= 59{,}280$ k-in
  $\lambda = 72"/ 9/16" = 128$
  $\lambda_p = 640 / \sqrt{50}$ ksi $= 91 < 128$
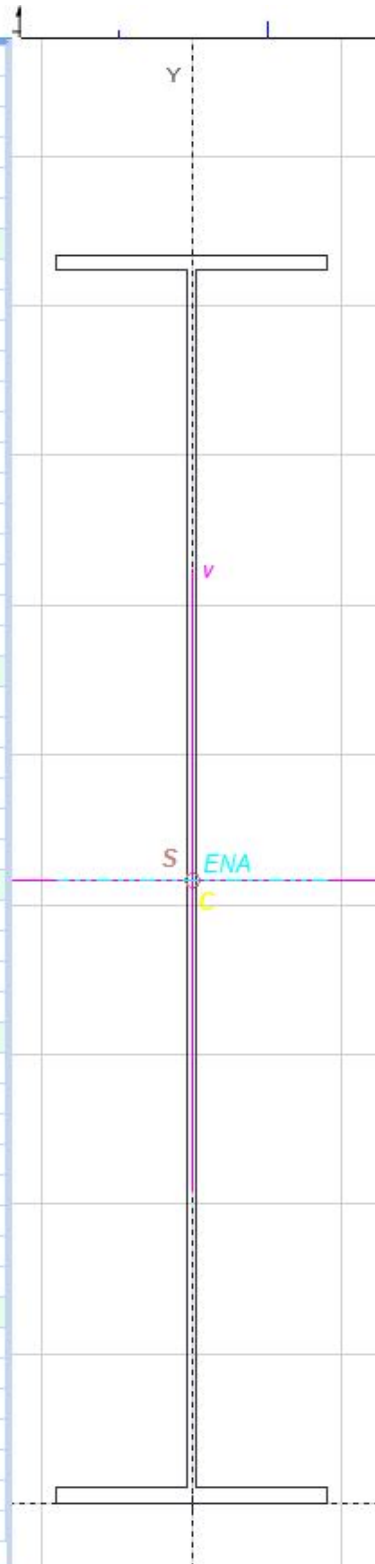 $\lambda_r = 970 / \sqrt{50}$ ksi $= 137 > 128 > 91$, web is non-compact.

$M_n = 87450 - (87450 - 59280) * (128 - 91) / (137 - 91) =$

$M_n = 64{,}791$ k-in >> LTB above, does not control.   Note, this is similar for other girders by inspection - do not need to check Web Local Buckling again. The reason is the girder is relatively unsupported, so LTB very stongly controls the nominal strength.

Axes Properties

Axes X-Y	
Ix (in^4)	+14.782E+04
Iy (in^4)	+59.840E+01
Ixy (in^4)	-30.380E-03
Io (in^4)	+14.842E+04
rx (in)	+46.453E+00
ry (in)	+29.556E-01
ro (in)	+46.547E+00
Centroidal Axes	
Ix (in^4)	+54.673E+03
Iy (in^4)	+59.840E+01
Ixy (in^4)	+22.795E-05
Io (in^4)	+55.272E+03
rx (in)	+28.252E+00
ry (in)	+29.556E-01
ro (in)	+28.406E+00
Y top (in)	+36.875E+00
Y bot (in)	+36.875E+00
Sx top (in^3)	+14.827E+02
Sx bot (in^3)	+14.827E+02
X right (in)	+80.000E-01
X left (in)	+80.000E-01
Sy right (in^3)	+74.800E+00
Sy left (in^3)	+74.801E+00
Zpx (in^3)	+17.492E+02
Zpy (in^3)	+11.770E+01
Max Mx (lbf.in)	+74.133E+06
Max My (lbf.in)	+37.400E+05
Mpx (lbf.in)	+87.462E+06
Mpy (lbf.in)	+58.848E+05
SFx	+11.798E-01
SFy	+15.735E-01
Principal Axes	
Ix (in^4)	+54.673E+03
Iy (in^4)	+59.840E+01
Ixy (in^4)	+22.795E-05
Io (in^4)	+55.272E+03
rx (in)	+28.252E+00
ry (in)	+29.556E-01
ro (in)	+28.406E+00
IMax (in^4)	+54.673E+03
IMin (in^4)	+59.840E+01
Theta (Deg)	+00.000E+00
Y top (in)	+36.875E+00
Y bot (in)	+36.875E+00
Sx top (in^3)	+14.827E+02
Sx bot (in^3)	+14.827E+02
X right (in)	+80.000E-01
X left (in)	+80.000E-01
Sy right (in^3)	+74.800E+00

General

Area	+68.500E+00 in^2
Mass/L	+19.454E+00 lb/ in
Xc	-12.117E-06 in
Yc	+36.875E+00 in
NA (Deg)	+0.0 Deg
PNA (x,y)	(+0.0,+36.88)
Torsion and Shear	
J (Torsion)	+91.773E-01 in^4
Cw (Warping)	+79.317E+04 in^6
Xs (Shear)	-14.270E-07 in
Ys (Shear)	+36.875E+00 in
Ax	+25.253E+00 in^2
Kx	+36.865E-02
Ay	+40.348E+00 in^2
Ky	+58.902E-02
Ios	+55.272E+03 in^4
ros	+28.406E+00 in
Swx	+13.129E-04 in^5
Swy	-58.447E-02 in^5
Dsc	+10.690E-06 in
Buckling	
ßx (monosymmetry)	-69.718E-13 in
ßy (monosymmetry)	+11.221E-04 in
Cx Stability	-36.719E-08 in^5
Cy Stability	+68.425E-02 in^5
ß Torsional-flexural	+10.000E-01
a Torsional-Bending	+47.221E+01 in
Transformed Composite Section	
Ref. User-Defined	+29.000E+06 psi
Transformed Area	+68.500E+00 in^2
Xcc	-12.117E-06 in
Ycc	+36.875E+00 in
Stressses Yield & Maximum	
Sig-yield T	+50.000E+03 psi
Sig-yield C	-50.000E+03 psi
Tau yield	+00.000E+00 psi
Sig-x max T	+67.446E-03 psi
Sig-x max C	-67.446E-03 psi
Fpt	+17.125E+05 lbf
Fpc	+17.125E+05 lbf
Np Column Capacity	+34.250E+05 lbf
Loads	
Moment Mx	+10.000E+01 lbf.in
Moment My	+00.000E+00 lbf.in
Axial N [.0,.0]	+00.000E+00 lbf
Torque Tz	+10.000E+01 lbf.in
Bimoment Bw	+10.000E+03 lbf.in²
Shear Vx	+10.000E+01 lbf
Shear Vy	+10.000E+01 lbf

Check girder A, controls over girder E. Pick at one location. Same section properties as girder C.

Check girder compactness:
    Flange is compact, web is non-compact.

Analysis for slender plate girders (AISC appendix G) is not applicable, as this girder is non-compact, not slender. See below for analysis.

    Check for unbraced length = 82' (entire girder), since there are no lateral braces:
    The plate girder is: web non-compact (not slender), flange compact.
    Flange:
        F_y = 50 ksi

    L_b = 82' = 984"
    L_p = 300*r_y/√Fy
        r_y = 2.95 in
    Lp = 300*2.95/√50 = 125"
    L_b > L_p, and L_b will be > L_r by inspection, so elastic LTB with non-compact section, and check LTB:
    Mn = Cb*π/Lb * √[E*Iy*G*J + (π*E/Lb)^2 * Iy*Cw] < Mp
        Take Cb = 1.0 since ends are not laterally supported
    Mn = 1.0*π/984" * √[29,000 ksi * 598.4 in4 * 11,200 ksi * 9.18 in4 + (π*29,000 ksi/984")^2 * 598.4 in4 * 79.3E4 in6] = (units 1/in * √(k2 * in4) = k-in)
    Mn = 7723 k-in;
    Mp = Fy*Zx = 50 ksi * 1749 in3 = 87,450 k-in so use Mn

Applied moment: take girder dead weight and add 3 k at each end for splice cages + splices (cages N/A on girder C). Lever arm = 984" / 2 = 492"
Load = 20 k girder + 0.295 k * 3 diaphragms = 20.89 k / 984" = 0.022 k/in

Mult = 0.022 k/in DL * 492^2/2 + 3 k * 492" = 4138 k-in, FoS = 7723 / 4138 = 1.86, **beam is okay with unsupported compression flange in Lateral-Torsional Bucking**.

Check girder B, same for girder D. Pick at one location. Note different section properties. Use smallest section for strength. Distribute weight evenly (conservative for bending).

Check girder compactness:
Flange:

λ = 20"/ 2*1.125" = 11.25
λp = 65/$\sqrt{50}$ ksi = 9.19
λr = 141 / $\sqrt{40}$ ksi = 22 > 11.25 > 9.19, flange is non-compact

Web:

λ = 72"/ 9/16" = 128
λp = 640 / $\sqrt{50}$ ksi = 91
λr = 970 / $\sqrt{50}$ ksi = 137 > 128 > 91, web is non-compact.

Analysis for slender plate girders (AISC appendix G) is not applicable, as this girder is non-compact, not slender. See below for analysis.

Check for unbraced length = 89' (entire girder), since there are no lateral braces:
The plate girder is: web non-compact (not slender), flange compact.
Flange:

F_y = 50 ksi

L_b = 89' = 1068"
L_p = 300*ry/$\sqrt{Fy}$

ry = 4.19 in

Lp = 300*4.19/$\sqrt{50}$ = 177"
L_b > L_p, and L_b will be > L_r by inspection, so elastic LTB with non-compact section, and check LTB:

Mn = Cb*π/Lb * $\sqrt{[E*Iy*G*J + (\pi*E/Lb)^2 * Iy*Cw]}$ < Mp

Take Cb = 1.0 since ends are not laterally supported

Mn = 1.0*π/1068" * $\sqrt{[29,000\ ksi * 1501\ in4 * 11,200\ ksi * 27.3\ in4 + (\pi*29,000\ ksi/1068")^2 * 1501\ in4 * 20.0E5\ in6]}$ = (units 1/in * $\sqrt{(k2 * in4)}$ = k-in)
Mn = 0.00242 * $\sqrt{[1.783E12 + 70.298^2 * 4.745E8]}$
Mn = 17,454 k-in;
Mp = Fy*Zx = 50 ksi * 2374 in3 = 118,700 k-in so use Mn

Applied moment: take girder dead weight and add 3 k at each end for splice cages (cages N/A on girder C). Lever arm = 1068" / 2 = 534"
Load = 31.3 k girder + 0.295 k * 3 diaphragms = 32.19 k / 1068" = 0.031 k/in

Mult = 0.031 k/in DL * 534^2/2 + 3 k * 534" = 6022 k-in, FoS = 17454 / 6022= 2.90, **beam is okay with unsupported compression flange in Lateral-Torsional Bucking**.

Web local buckling okay by inspection, above.
Check Flange local buckling: noncompact
Mn = Mp – (Mp – Mr) * (λ – λp) / (λr – λp) < Mp

Mp = 118,700 k-in (above)
Mr = (Fy-Fr)*Sx = 40 ksi * 2091 in3 = 83,640 k-in

λ = 20"/ 2*1.125" = 11.25
λp = 65/√50 ksi = 9.19
λr = 141 / √40 ksi = 22 > 11.25 > 9.19, flange is non-compact

Mn = 118700 – (118700 – 83640) * (11.25 – 9.19) / (22 – 9.19) =
Mn = 113,061 k-in >> LTB above, does not control.   Note, this is similar for other girders by inspection - do not need to check Flange Local Buckling again.

Axes Properties	Custom	General		Axes Properties	Custom	General
Axes X-Y				Area		+85.500E+00 in^2
Ix (in^4)		+19.550E+04		Mass/L		+24.282E+00 lb/ in
Iy (in^4)		+15.011E+02		Xc		-15.343E-06 in
Ixy (in^4)		-48.234E-03		Yc		+37.125E+00 in
Io (in^4)		+19.700E+04		NA (Deg)		+0.0 Deg
rx (in)		+47.818E+00		PNA (x,y)		(+0.0,+37.13)
ry (in)		+41.900E-01		**Torsion and Shear**		
ro (in)		+48.001E+00		J (Torsion)		+27.319E+00 in^4
Centroidal Axes				Cw (Warping)		+20.050E+05 in^6
Ix (in^4)		+77.657E+03		Xs (Shear)		-22.795E-09 in
Iy (in^4)		+15.011E+02		Ys (Shear)		+37.125E+00 in
Ixy (in^4)		+46.622E-05		Ax		+39.706E+00 in^2
Io (in^4)		+79.159E+03		Kx		+46.440E-02
rx (in)		+30.138E+00		Ay		+41.164E+00 in^2
ry (in)		+41.900E-01		Ky		+48.145E-02
ro (in)		+30.427E+00		Ios		+79.159E+03 in^4
Y top (in)		+37.125E+00		ros		+30.427E+00 in
Y bot (in)		+37.125E+00		Swx		+51.356E-05 in^5
Sx top (in^3)		+20.918E+02		Swy		-11.897E-01 in^5
Sx bot (in^3)		+20.918E+02		Dsc		+15.320E-06 in
X right (in)		+10.000E+00		**Buckling**		
X left (in)		+10.000E+00		ßx (monosymmetry)		-94.066E-13 in
Sy right (in^3)		+15.011E+01		ßy (monosymmetry)		+80.913E-05 in
Sy left (in^3)		+15.011E+01		Cx Stability		-68.304E-08 in^5
Zpx (in^3)		+23.743E+02		Cy Stability		+12.606E-01 in^5
Zpy (in^3)		+23.070E+01		ß Torsional-flexural		+10.000E-01
Max Mx (lbf.in)		+10.459E+07		a Torsional-Bending		+43.515E+01 in
Max My (lbf.in)		+75.054E+05		**Transformed Composite Section**		
Mpx (lbf.in)		+11.872E+07		Ref. User-Defined		+29.000E+06 psi
Mpy (lbf.in)		+11.535E+06		Transformed Area		+85.500E+00 in^2
SFx		+11.351E-01		Xcc		-15.343E-06 in
SFy		+15.369E-01		Ycc		+37.125E+00 in
Principal Axes				**Stressses Yield & Maximum**		
Ix (in^4)		+77.657E+03		Sig-yield T		+50.000E+03 psi
Iy (in^4)		+15.011E+02		Sig-yield C		-50.000E+03 psi
Ixy (in^4)		+46.622E-05		Tau yield		+00.000E+00 psi
Io (in^4)		+79.159E+03		Sig-x max T)		+47.806E-03 psi
rx (in)		+30.138E+00		Sig-x max C)		-47.806E-03 psi
ry (in)		+41.900E-01		Fpt		+21.375E+05 lbf
ro (in)		+30.427E+00		Fpc		+21.375E+05 lbf
IMax (in^4)		+77.657E+03		Np Column Capacity		+42.750E+05 lbf
IMin (in^4)		+15.011E+02		**Loads**		
Theta (Deg)		+00.000E+00		Moment Mx		+10.000E+01 lbf.in
Y top (in)		+37.125E+00		Moment My		+00.000E+00 lbf.in
Y bot (in)		+37.125E+00		Axial N [.0,.0]		+00.000E+00 lbf
Sx top (in^3)		+20.918E+02		Torque Tz		+10.000E+01 lbf.in
Sx bot (in^3)		+20.918E+02		Bimoment Bw		+10.000E+03 lbf.in²
X right (in)		+10.000E+00		Shear Vx		+10.000E+01 lbf
X left (in)		+10.000E+00		Shear Vy		+10.000E+01 lbf
Sy right (in^3)		+15.011E+01				

138 HSL
110' of Boom

Tube Boom Load Chart

Load Radius ft (m)	Boom Length – ft (m)									
	40 (12.2)	50 (15.2)	60 (18.3)	70 (21.3)	80 (24.4)	90 (27.4)	100 (30.5)	110 (33.5)	120 (36.6)	130 (39.6)
11 (3.4)	160.0 (72.6)									
12 (3.7)	160.0 (72.6)	160.0 (72.6)								
13 (4.0)	151.8 (68.9)	151.6 (68.8)								
14 (4.3)	141.6 (64.2)	141.4 (64.1)	141.1 (64.0)							
15 (4.6)	132.6 (60.1)	132.4 (60.1)	132.2 (60.0)							
16 (4.9)	124.7 (56.6)	124.5 (56.5)	124.3 (56.4)	123.9 (56.2)						
17 (5.2)	117.6 (53.3)	117.5 (53.3)	117.3 (53.2)	117.0 (53.1)						
18 (5.5)	111.1 (50.4)	111.2 (50.4)	111.0 (50.3)	110.7 (50.2)	109.0 (49.4)					
19 (5.8)	101.7 (46.1)	101.9 (46.2)	102.0 (46.3)	102.1 (46.3)	102.1 (46.3)	99.3 (45.0)				
20 (6.1)	93.7 (42.5)	93.9 (42.6)	94.0 (42.6)	94.1 (42.7)	94.1 (42.7)	94.0 (42.6)				
25 (7.6)	67.0 (30.4)	67.1 (30.4)	67.2 (30.5)	67.2 (30.5)	67.1 (30.4)	67.1 (30.4)	67.0 (30.4)	66.9 (30.3)	66.8 (30.3)	
30 (9.1)	51.8 (23.5)	51.9 (23.5)	52.0 (23.6)	52.0 (23.6)	51.9 (23.5)	51.8 (23.5)	51.7 (23.5)	51.6 (23.4)	51.5 (23.4)	51.4 (23.3)
35 (10.7)	42.0 (19.1)	42.2 (19.1)	42.2 (19.1)	42.1 (19.1)	42.1 (19.1)	42.0 (19.1)	41.9 (19.0)	41.8 (19.0)	41.6 (18.9)	41.5 (18.8)
40 (12.2)	35.1 (15.9)	35.3 (16.0)	35.3 (16.0)	35.3 (16.0)	35.2 (16.0)	35.1 (15.9)	35.0 (15.9)	34.9 (15.8)	34.7 (15.7)	34.6 (15.7)
50 (15.2)		26.3 (11.9)	26.4 (12.0)	26.4 (12.0)	26.3 (11.9)	26.2 (11.9)	26.0 (11.8)	25.9 (11.7)	25.8 (11.7)	25.6 (11.6)
60 (18.3)				20.8 (9.4)	20.7 (9.4)	20.6 (9.3)	20.4 (9.3)	20.3 (9.2)	20.2 (9.2)	20.0 (9.1)
70 (21.3)					16.9 (7.7)	16.7 (7.6)	16.6 (7.5)	16.5 (7.5)	16.3 (7.4)	16.2 (7.3)
80 (24.4)						14.0 (6.4)	13.8 (6.3)	13.7 (6.2)	13.5 (6.1)	13.4 (6.1)
90 (27.4)							11.7 (5.3)	11.6 (5.3)	11.4 (5.2)	11.3 (5.1)
100 (30.5)								9.9 (4.5)	9.8 (4.4)	9.6 (4.4)
110 (33.5)									8.4 (3.8)	8.3 (3.8)
120 (36.6)										7.1 (3.2)

Link-Belt HTC-86100 100-ton crane

39,500 lb Counterweight — Fully Extended Outriggers — 360° Rotation
(All Capacities Are Listed In Pounds)

Radius (ft)	38	50	60	70	76.5/80	90	100	110	120	130	140	Radius (ft)
7	200,000***											7
8	180,000*											8
9	167,600*											9
10	158,800*	152,100*	117,900	89,700								10
12	143,600*	138,700*	108,800	85,000	85,100**							12
15	123,700	122,600	106,500	78,800	78,400**	57,700						15
20	91,300	93,500	93,800	70,300	76,500**	56,200	49,100	42,500				20
25	71,000	73,300	73,800	63,600	73,300**	55,300	45,800	42,500	33,700	29,700		25
30	57,200	59,600	60,100	58,100	61,100	54,500	45,200	38,300	31,200	29,400	24,400	30
35		49,700	50,300	51,400	51,200	50,900	42,500	35,500	30,900	29,100	24,100	35
40		42,200	43,700	44,000	43,800	43,400	38,200	33,400	30,600	28,800	24,000	40
45			37,900	38,200	38,100	37,700	34,600	30,300	29,900	28,600	23,800	45
50			32,400	32,700	32,500	32,000	31,500	27,900	27,800	26,800	23,700	50
55				28,200	28,000	27,600	27,300	25,600	25,800	24,800	23,600	55
60				24,600	24,500	24,100	24,100	23,600	24,200	23,000	22,100	60
65					21,500	22,300	21,100	21,400	21,600	21,300	20,600	65
70					19,700	19,900	18,700	19,500	19,100	19,200	19,200	70
75						17,700	17,500	17,400	17,000	17,700	17,400	75
80						16,000	16,000	15,600	15,900	15,900	15,600	80
85							14,600	14,600	14,800	14,400	14,100	85
90							13,800	13,700	13,400	13,000	12,700	90
95								12,500	12,300	11,900	11,600	95
100								11,500	11,200	10,900	10,600	100
105									10,200	9,900	9,600	105
110									9,400	9,000	8,800	110
115										8,300	8,000	115
120										7,500	7,300	120
125											6,600	125
130											6,000	130

* Special Conditions Or Wire Rope Required
** 76.5 EM5 mode
*** Over Rear

5650 (supersedes 5620)—0913—J7   *full counterweight*   13

Main Boom Lift Capacity Charts — Imperial

Radius (ft)	26,000 lb Counterweight — Fully Extended Outriggers — 360° Rotation (All Capacities Are Listed In Pounds)												Radius (ft)
	Boom Length (ft)												
	40	50	60	70	80	90	100	110	120	130	140	150	
10	*220,000	107,200	105,400	101,500									10
12	187,600	107,200	105,400	101,500	101,300								12
15	164,600	107,200	105,400	101,500	96,600	81,900	56,500						15
20	123,400	107,200	105,400	101,500	80,800	73,200	65,900	56,000					20
25	95,800	95,400	94,000	87,800	69,000	62,700	60,100	56,000	58,000				25
30	77,200	76,900	76,600	76,300	59,900	55,000	53,500	56,000	51,300	48,600	38,400	30,000	30
35		63,700	63,400	63,200	53,200	53,000	53,500	51,800	45,400	43,100	38,400	30,000	35
40		52,400	52,000	52,000	53,200	52,800	52,800	46,300	40,600	38,500	37,000	30,000	40
45			43,600	44,200	44,700	42,900	43,000	41,700	36,500	34,600	33,300	30,000	45
50			36,100	36,900	37,300	37,600	35,600	35,700	33,000	31,300	30,200	29,100	50
55				31,300	31,800	32,100	30,200	30,300	30,000	28,500	27,500	26,500	55
60				26,800	27,300	27,600	27,900	25,900	25,900	25,900	25,100	24,200	60
65					23,700	24,000	24,300	23,600	22,400	22,400	22,400	22,100	65
70					20,700	21,100	21,300	21,500	19,900	19,500	19,500	19,500	70
75						18,600	18,800	19,000	18,500	17,100	17,200	17,200	75
80						16,500	16,800	17,000	17,200	15,100	15,100	15,200	80
85							14,900	15,200	15,400	13,300	13,300	13,400	85
90							13,300	13,600	13,800	11,700	11,800	11,800	90
95								12,200	12,400	10,400	10,400	10,400	95
100								10,900	11,100	9,100	9,120	9,200	100
105									10,000	8,100	8,100	8,100	105
110									9,000	7,100	7,100	7,100	110
115										6,200	6,200	6,300	115
120										5,400	5,400	5,500	120
125											4,700	4,800	125
130											4,000	4,100	130
135												3,500	135
140												2,900	140

* Special conditions or optional equipment required

Link-Belt ATC 3210:

5654–1013–S3 Preliminary

FULL WEIGHTS (handwritten)

115,500 lb Counterweight - Fully Extended Outriggers - 360° Rotation
(All Capacities Are Listed In Pounds)

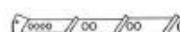| Radius (ft)	44.3	58.9–59.8	73.5–75.9	88.6–92.4	103.7–107.5	119.3–124.1	134.9–136.8	151.9–153.3	167–168.9	183.6–186.5	200.1	Radius (ft)
8	420,000**											8
10	300,000	297,300	282,200	212,200								10
12	288,200	269,500	256,800	212,200								12
15	233,200	235,200	232,200	205,500	128,900							15
20	189,400	192,100	191,000	184,600	172,300	129,700	91,400					20
25	157,800	160,900	160,000	158,700	153,000	126,900	91,400	73,000	41,200			25
30	133,000	137,200	136,900	135,000	136,500	118,300	85,500	73,000	55,000	41,300		30
35	111,300	115,700	117,000	116,700	115,300	107,800	79,100	73,000	55,000	41,300	33,000	35
40		99,400	100,700	100,500	99,200	98,900	73,500	69,700	55,000	41,300	33,000	40
45		87,400	87,800	87,700	86,500	88,000	68,600	63,800	55,000	41,300	33,000	45
50		76,100	77,500	77,400	77,400	77,900	64,100	58,800	53,500	41,300	33,000	50
55			70,700	70,800	70,800	69,400	60,400	54,300	50,500	41,300	33,000	55
60			63,700	64,200	63,800	62,400	57,000	50,100	47,600	40,200	33,000	60
65			55,900	58,200	57,700	56,300	54,000	46,500	44,300	37,800	33,000	65
70				53,000	52,500	51,300	51,300	43,300	41,400	35,600	33,000	70
75				48,500	48,000	46,800	48,100	40,500	38,700	33,700	32,600	75
80				42,200	44,100	42,900	44,100	37,900	36,400	31,900	30,800	80
85					40,100	40,000	40,100	36,800	34,200	30,200	29,100	85
90					38,600	38,000	36,600	33,400	32,200	28,600	27,600	90
95					33,600	34,900	33,700	31,700	30,300	27,200	26,200	95
100						32,300	31,000	30,400	28,600	25,800	25,000	100
105						29,900	28,500	29,100	27,100	24,400	23,800	105
110						25,000	26,400	27,100	25,600	23,000	22,400	110
115						20,600	24,400	25,100	24,100	21,600	21,400	115
120							23,300	23,300	22,300	20,400	20,400	120
125							21,000	21,700	20,700	19,400	19,600	125
130								20,200	19,200	18,300	18,700	130
135								18,800	17,800	17,100	17,700	135
140								17,600	16,700	15,900	16,700	140
145									15,500	15,000	15,600	145
150									14,500	14,400	14,500	150
155									13,500	13,600	13,500	155
160									10,200	13,200	12,500	160
165										12,500	11,700	165
170										11,700	10,800	170
175										9,300	10,100	175
180											9,400	180
185											8,700	185

Note: Capacities depict multiple boom modes.
** Over rear intermediate outriggers, additional equipment required.

Link-belt RTC 8050 II:

Rated Lifting Capacities In Pounds — Fully Extended Outriggers — See Set Up Note 2 — FULL — MAIN BOOM "A"

Load Radius (Ft.)	35.5 Ft. ∡°	360°	Over Front	40 Ft. ∡°	360°	Over Front
10	68.0	100,000	100,000	70.5	78,400	78,400
12	64.5	73,900	75,400	67.5	73,100	73,100
15	58.5	63,200	64,400	62.5	63,000	63,800
20	48.0	50,300	51,300	54.0	50,100	51,200
25	34.5	39,000	40,900	44.0	38,900	40,700
30				31.0	30,800	32,300
Min.Bm. Ang.Cap.	0 (30.0)	17,800	17,800	0 (34.5)	15,300	15,300

Load Radius (Ft.)	50 Ft. ∡°	360°	Over Front	60.3 Ft. ∡°	360°	Over Front
10	75.0	72,600	72,600			
12	72.5	65,600	65,600	76.5	50,900	50,900
15	69.0	57,500	57,500	73.5	46,900	46,900
20	62.5	47,600	47,600	68.5	39,200	39,200
25	55.5	38,500	40,200	63.0	33,400	33,400
30	48.0	30,500	32,100	57.5	28,700	28,700
35	39.0	24,800	26,100	51.0	24,600	25,200
40	27.5	19,100	20,400	44.0	18,900	20,200
45				36.0	14,900	16,000
50				26.0	11,800	12,800
Min.Bm. Ang.Cap.	0 (44.5)	10,100	10,100	0 (54.8)	6,500	6,500

Rated Lifting Capacities In Pounds — Fully Extended Outriggers — See Set Up Note 2 — FULL — MAIN BOOM "B"

Load Radius (Ft.)	35.5 Ft. ∡°	360°	Over Front	40 Ft. ∡°	360°	Over Front	50 Ft. ∡°	360°	Over Front
10	68.0	100,000	100,000	70.5	37,900	37,900	74.5	37,900	37,900
12	64.5	73,900	75,400	67.5	37,900	37,900	72.5	37,900	37,900
15	58.5	63,200	64,400	62.5	37,900	37,900	69.0	37,900	37,900
20	48.0	50,300	51,300	54.0	37,900	37,900	62.5	37,900	37,900
25	34.5	39,000	40,900	44.0	37,900	37,900	55.5	37,900	37,900
30				31.0	31,300	32,900	48.0	31,900	33,500
35							39.0	26,100	27,500
40							27.5	20,800	22,100
Min.Bm Ang Cap	0 (30.0)	17,800	17,800	0 (34.5)	14,700	14,700	0 (44.5)	9,900	9,900

Load Radius (Ft.)	60 Ft. ∡°	360°	Over Front	70 Ft. ∡°	360°	Over Front	80 Ft. ∡°	360°	Over Front
10	77.5	37,900	37,900						
12	76.0	37,900	37,900	78.0*	37,900	37,900			
15	73.0	37,900	37,900	76.0	37,900	37,900	78.0*	35,400	35,400
20	68.0	37,900	37,900	72.0	37,900	37,900	74.5	34,700	34,700
25	62.5	37,900	37,900	67.5	37,900	37,900	71.0	34,200	34,200
30	56.5	32,300	33,900	62.5	32,500	32,800	67.0	30,300	30,300
35	50.5	26,500	27,800	57.5	26,700	28,100	63.0	26,900	27,200
40	43.5	21,200	22,500	52.5	21,400	22,700	58.5	21,500	22,800
45	35.5	17,100	18,200	46.5	17,300	18,400	54.0	17,400	18,500
50	25.0	13,900	14,900	40.5	14,200	15,200	49.0	14,300	15,300
55				33.0	11,900	12,700	44.0	12,100	12,800
60				23.5	10,000	10,700	38.0	10,200	10,900
65							31.0	8,600	9,300
70							22.0	7,300	7,900
MinBm Ang Cap	0 (54.5)	7,000	7,000	0 (64.5)	5,000	5,000	0 (74.5)	3,500	3,500

| Load Radius (Ft.)	90 Ft. ∡°	360°	Over Front	100 Ft. ∡°	360°	Over Front	110 Ft. ∡°	360°	Over Front
20	77.0	28,900	28,900						
25	74.0	28,200	28,200	76.0	24,000	24,000	77.5	19,500	19,500
30	70.5	24,800	24,800	73.0	22,500	22,500	75.0	19,500	19,500
35	67.0	22,000	22,000	70.0	19,900	19,900	72.5	18,300	18,300
40	63.5	19,700	19,700	67.0	17,800	17,800	70.0	16,400	16,400
45	59.5	17,500	17,800	63.5	15,900	15,900	67.0	14,600	14,600
50	55.5	14,400	15,400	60.5	14,400	14,400	64.0	13,200	13,200
55	51.0	12,200	12,900	56.5	12,200	13,000	61.0	12,100	12,100
60	46.5	10,300	11,000	53.0	10,300	11,100	57.5	10,400	11,000
65	41.5	8,700	9,400	49.0	8,800	9,500	54.0	8,900	9,600
70	36.0	7,500	8,100	44.5	7,500	8,200	50.5	7,600	8,200
75	29.5	6,400	6,900	40.0	6,500	7,100	47.0	6,500	7,100
80	21.0	5,400	6,000	34.5	5,500	6,100	42.5	5,600	6,200
85				28.5	4,700	5,200	38.5	4,800	5,300
90				20.5	4,000	4,500	33.5	4,100	4,600
95							27.5	3,500	3,900
100							20.0	2,900	3,400
MinBm Ang Cap	0 (84.5)	2,400	2,400	0 (94.5)	1,600	1,600	0 (104.5)	900	900

BEAM CLAMPS

Beam clamps provide an efficient method for handling wide flange beam sections and plate girders. When lifting, they grip the beam at three points. When properly balanced and safely guided, the beam can be handled even if the clamp is slightly off center lengthwise.

Good safety procedures providing control of the lifted beam must be used. Beams should be gripped as near the center as possible. Snubbing lines at each end must be used to control excessive twisting or swinging, and to guide the beam to its proper place. Each lifting situation may have specific safety demands which should be used as required.

Beam clamps eliminate the need for slings, chokers, and spreader bars. The weight of the beam clamp automatically opens its tongs, which slide under the flanges of the beam. When the clamp is lifting, its center plate and gripping tongs work against each other—the heavier the beam, the greater the clamping pressure.

Model "NS" clamps have a recessed base to accept studs welded to a beam surface.
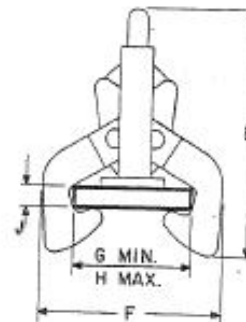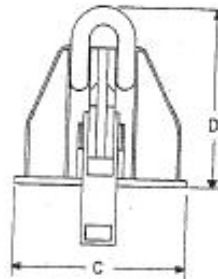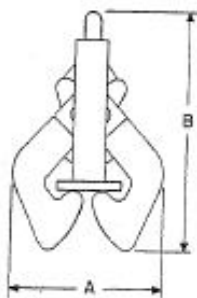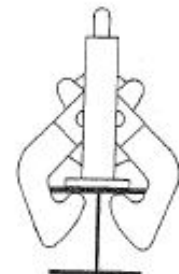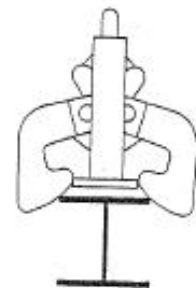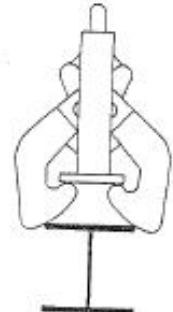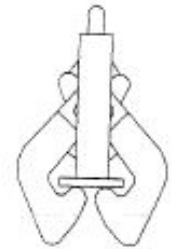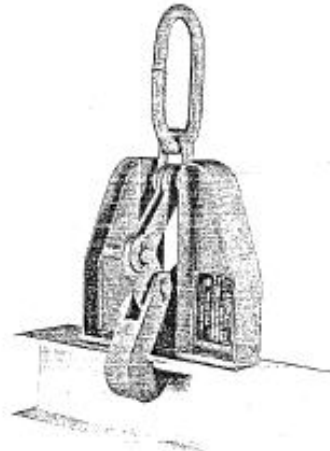
| Model No. | Working Load Limit Tons | FlangeGrip | | WL. Lbs. | Dimensions | | | | | | | | |
		Width Range Min. Max.	Depth		A	B	C	D	E	F	G	H	J
F-5	5	4 to10	1	51	9 1/2	26	12	20	25 1/2	16 3/4	4	10	1
F-15	15	7 to17	2	125	15 1/2	34	17	27	34 1/2	25	7	17	2
NS-15	15	7 to17	2	120	15 1/2	34	17	27	34 1/2	25	7	17	2
F-25	25	16 to 24	3	244	23	48	22 1/4	36	53	37 1/4	16	24	3
NS-25	25	16 to 24	3	234	23	48	22 1/4	36	53	37 1/4	16	24	3
F-35	35	16 to 36	4	495	30	64	27 1/2	48	58	53	16	36	4
NS-35	35	16 to 36	4	484	30	64	27 1/2	48	58	53	16	36	4
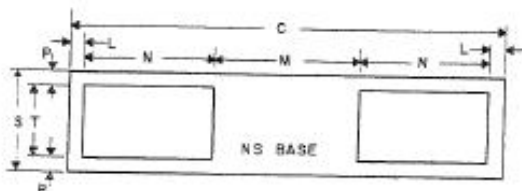
| Model Number | NS Base Dimensions, Inches | | | | | | |
	S	C	N	T	M	L	P
NS-15	4	16 1/2	4 1/2	2 1/2	6 1/2	1/2	3/4
NS-25	5 1/2	22 1/4	6 1/2	4	7 3/4	3/4	3/4
NS-35	6	27 1/2	8 1/2	4 1/2	9	3/4	3/4

NS BASE

WARNING: Decreasing the load by bumping or substantial imbalance can, under certain circumstances, loosen the grip. Do not use on flange widths less than those specified on the name plate. Do not exceed working load limit.

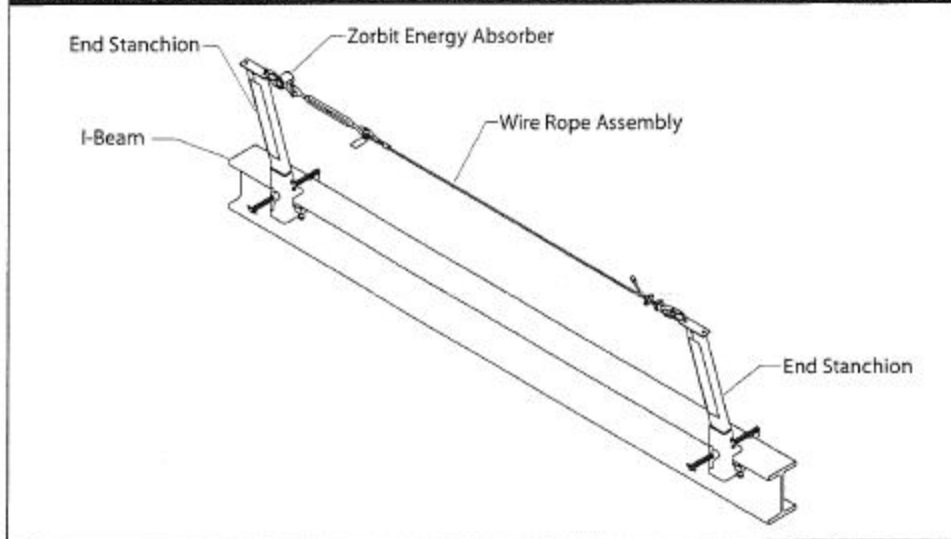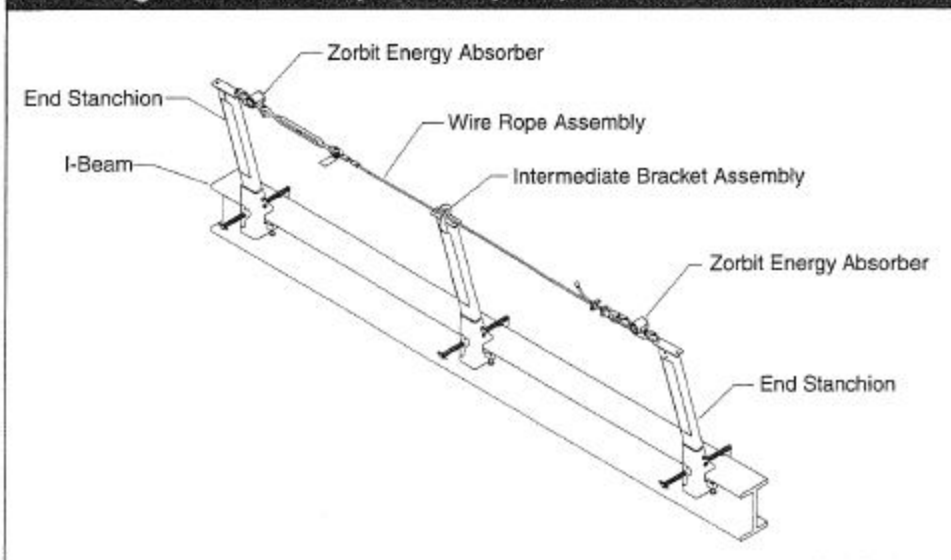**Figure 1 - SecuraSpan® Single Span Horizontal Lifeline**

End Stanchion — Zorbit Energy Absorber

I-Beam — Wire Rope Assembly

End Stanchion

Figure 2 - SecuraSpan® Multiple Span Horizontal Lifeline

Zorbit Energy Absorber

End Stanchion — Wire Rope Assembly

I-Beam — Intermediate Bracket Assembly

Zorbit Energy Absorber

End Stanchion

1.0 APPLICATION

1.1 **PURPOSE:** SecuraSpan® Horizontal Lifeline systems (HLL) are designed to be used as an anchoring means for up to six personal fall arrest systems (PFAS). The SecuraSpan system may be used in many situations where a combination of horizontal mobility and fall protection is needed. Figures 1 and 2 show two configurations of the SecuraSpan HLL systems.
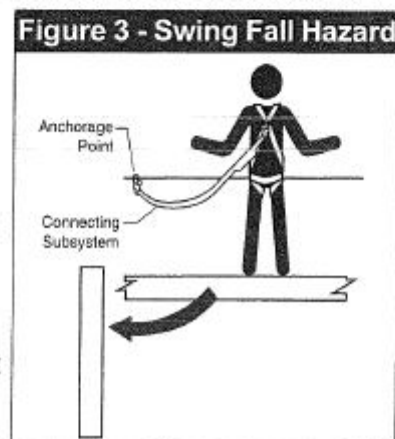
1.2 **LIMITATIONS:** The following limits apply to the installation and use of the SecuraSpan Horizontal Lifeline System. Other limitations may apply.
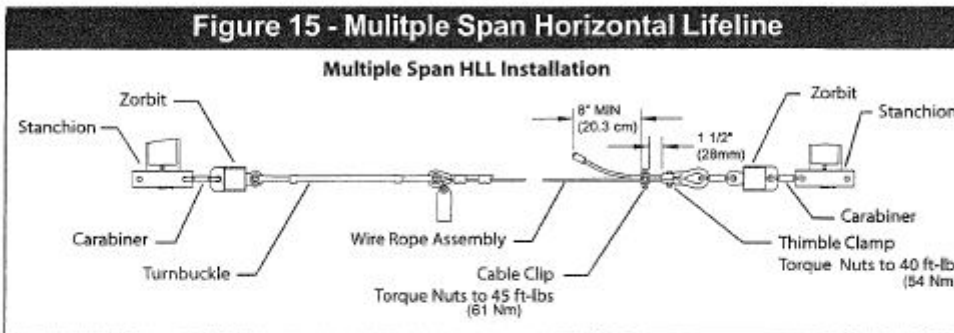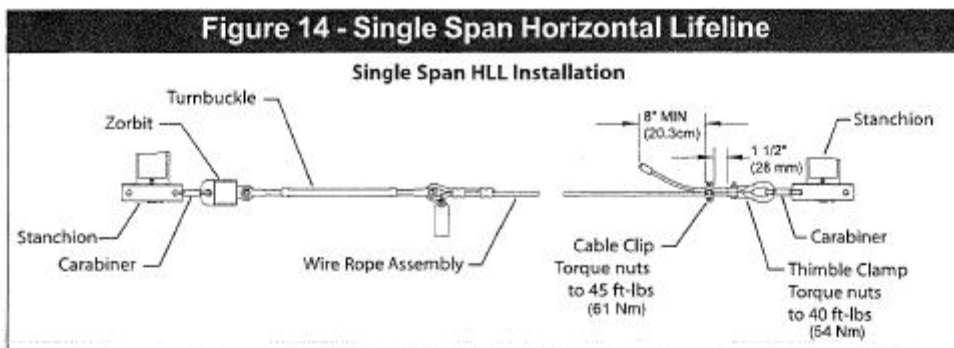
A. **HORIZONTAL LIFELINE SPAN:** The maximum horizontal lifeline span length is 60 ft. (18.3 m). The system length can be extended by using multiple spans. See Figure 2. The span length must be reduced when clearance is limited. See section 3.0 for clearance information

B. **ANCHORAGES:** SecuraSpan® Horizontal Lifeline (HLL) systems must only be installed to anchorages capable of meeting the strength requirements specified in Section 2.4.

C. **SYSTEM CAPACITY:** The capacity of single span systems is two persons. The capacity of multiple span systems is two persons secured on each span with a maximum of six people installed on the system. The maximum weight of each person, including tools and clothing, is 310 lbs (141 kg).

D. **CONNECTING SUBSYSTEM:** Each person's connecting subsystem (energy absorbing lanyard or SRL) must limit fall arrest forces to 900 lbs. (4 kN) or less. See section 2.1.

E. **FREE FALL:** Rig and use the personal fall arrest system such that the maximum potential free fall does not exceed government regulatory and subsystem manufacturer's requirements. See section 3.0 and subsystem manufacturer's instructions for more information.

F. **SWING FALLS:** See Figure 3. Swing falls occur when the anchorage point is not in line vertically with the worker. The force of striking an object in a swing fall may cause serious injury or death. Minimize swing falls by working as directly in line with the anchorage point as possible. Do not permit a swing fall if injury could occur. Swing falls will significantly

Figure 3 - Swing Fall Hazard

Anchorage Point

Connecting Subsystem

Figure 14 - Single Span Horizontal Lifeline

Single Span HLL Installation

Turnbuckle
Zorbit
Stanchion
Carabiner
Wire Rope Assembly
8" MIN (20.3cm)
1 1/2" (28 mm)
Stanchion
Cable Clip Torque nuts to 45 ft-lbs (61 Nm)
Carabiner
Thimble Clamp Torque nuts to 40 ft-lbs (54 Nm)

Figure 15 - Mulitple Span Horizontal Lifeline

Multiple Span HLL Installation

Zorbit
Stanchion
Carabiner
Turnbuckle
Wire Rope Assembly
Cable Clip Torque Nuts to 45 ft-lbs (61 Nm)
8" MIN (20.3 cm)
1 1/2" (28mm)
Zorbit
Stanchion
Carabiner
Thimble Clamp Torque Nuts to 40 ft-lbs (54 Nm)

is 6 in. (15.25 cm) or less, with no weight on the wire rope. The turnbuckle will not over tension the wire rope.

Step 6. After pre-loading the system, re-torque all cable clips to values specified previously.

NOTE: *Two independent SecuraSpan HLL systems may be terminated at the same stanchion.*
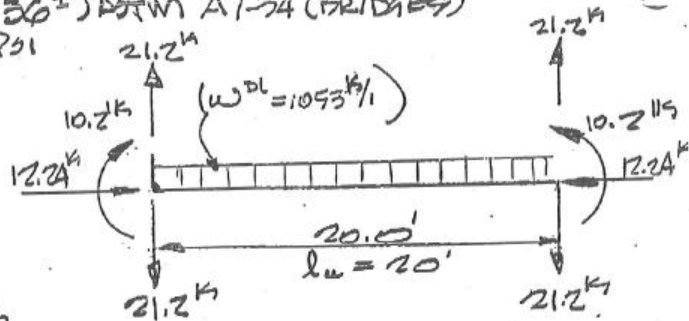
3.3 OPERATION:

A. **PERSONAL FALL ARREST SYSTEM COMPONENTS:** Inspect and don the full body harness according to manufacturer's instructions. Attach the connecting subsystem (energy absorbing lanyard or SRL) to the dorsal connection on the harness.

WARNING: *Risk of swing falls is greater when using an SRL. Swing falls significantly increase the clearance required to arrest a fall and may result in serious injury or death. To avoid swing fall hazards, do not work beyond the end stanchions or at excessive distances to either side of the HLL system. Do not climb above the HLL system.*

B. **CONNECTING TO THE HLL SYSTEM:** Approach the work area using the appropriate access equipment. Connect the personal fall arrest system (the free snap hook on the enegry absorbing lanyard or carabiner attached to the SRL) to the horizontal lifeline.

SPREADER BEAM   CAPACITY CHECK FOR 20 TON PICK

OR HP 12×53
    12 B 53 (1936±) ASTM A7-34 (BRIDGES)
    $F_y = 33,000$ PSI

$w^{DL} = .053^{k/l}$

21.2^k 10.2^k 12.24^k (at left, up/angled)

21.2^k 10.2^{lb} 12.24^k (at right)

20.0'
$l_u = 20'$

21.2^k 21.2^k

SECTION PROPERTIES:
12 B 53

12.00" (12¹⁄₁₆)

0.345"

0.576" (⁹⁄₁₆)

10.00"
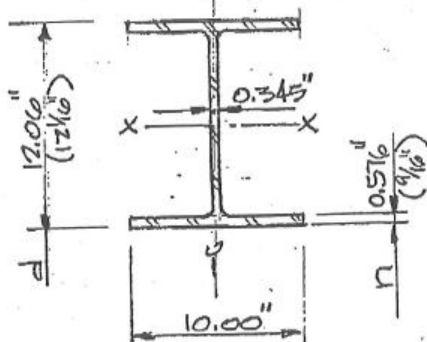
X-X	Y-Y
$I_x = 426.2$ in^4	$I_y = 96.1$ in^4
$S_x = 70.7$ in^3	$S_y = 19.2$ in^3
$r_x = 5.23$	$r_y = 2.48$ in

$A = 15.59$ in^2

$L_u = 21.7'$ $L_c = 10.6'$

NOTE: ACTUAL SECTION IS STRAIGHT & TRUE & OBTAINED FROM HEINEBERG BR. SALVAGE.

BENDING MOMENT

① BEAM DL: $M_x^{DL} = .125 \times .053 \times 20^2$
= 2.65 ^{in}

② END COUPLE: $M_x^e = 12.24^k \times 0.83'$
(P = 10") = 10.16 ^{in}

$\Sigma M_x^{DL+e} = 12.81$ ^{in}

$f_{bx} = \dfrac{12.81^{in} \times 12}{70.7} = 2.17$ ^{KSI}

AXIAL STRESS

$K = 1.0$ $\dfrac{Kl}{r_y} = \dfrac{1.0 \times 20 \times 12}{2.48}$

$= 96.77$

$f_{ay} = \dfrac{12.24^k}{15.59 \text{ in}^2} = 0.785$ KSI

$F_{ay} \cong 12.71$ KSI

$\dfrac{f_a}{F_a} = \dfrac{0.785^{KSI}}{12.71^{KSI}} = 0.062 < 0.15$

USE COMBINED STRESS = $\dfrac{f_a}{F_a} + \dfrac{f_b}{F_b}$

(-) COMPRESSION
(+) TENSION

20'-0" C.C
PIN PLATES

±½"×1½" PENDANT

60° ±

6" ±

±2½" Ø PIN HOLE (TYP)

21.2ᵏ

(+)24.5 KIPS

6"

$P_{\#} = 21.2 \, TAN \, 30°$
$= 12.24^k$

$P^{PEND} = \dfrac{21.2}{\cos 30°} = 24.48^k$

12.24ᵏ

$m^e = 12.24^k \times 0.83$
$= 10.16^{ft-k}$

(-)12.24ᵏ

(+)21.2ᵏ

℄

Scale: 1½" = 1'-0"

HP12×93

5/8 ±

2 ᴱᴬ - 8"(MIN) × ½"(MIN) × 2'-4" LG
PIN R'S (N.S. & F.S.)
℄ HP12×102

CORD
RIGGING
+HP12

20ᴷ
1.2
21.2ᵏ
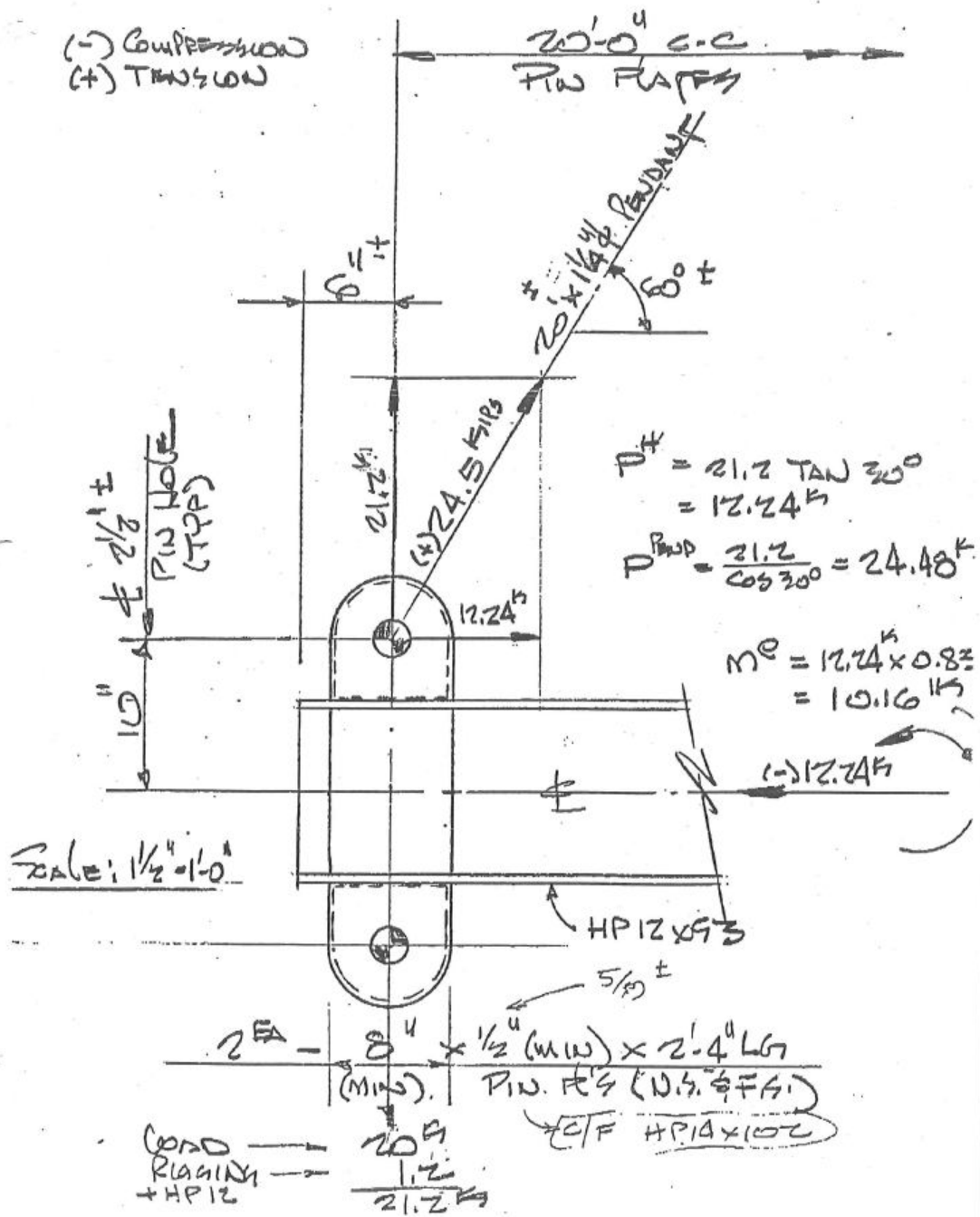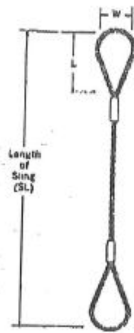
RATED CAPACITIES IN TONS OF 2000 LB—PURPLE-FLEX ROPE — MECHANICAL

Diam of Rope in.	Min Length (SL) of Sling ft-in.	Inside Loop Dimensions		Rated Capacities S/F 5				
		W in.	L in.	Choker Hitch	Single Part Vertical	Basket Hitch when used		
						30°	45°	60°
3/8	2	3	6	0.8	1.1	2.0	1.6	1.1
1/2	2—6	4	8	1.5	2.0	3.4	2.7	2.0
5/8	3	5	10	2.3	3.0	5.3	4.3	3.0
3/4	3—6	6	12	3.0	4.0	6.9	5.7	4.0
7/8	4	7	14	4.0	5.3	9.2	7.5	5.3
1	4—6	8	16	5.1	6.8	12	9.5	6.8
1 1/8	5	9	18	6.2	8.3	14	12	8.3
1 1/4	5—6	10	20	7.5	10	17	14	10
1 3/8	6	11	22	8.8	12	20	17	12
1 1/2	7	12	24	10	14	24	20	14
1 3/4	8	14	28	13	18	31	25	18

Rated capacities of basket hitches are based on a minimum diameter of curvature at the point of load contact of 10 times the rope diameter.
Length of sling (SL) is measured as indicated on sketch.

RATED CAPACITIES IN TONS OF 2,000 LB—PURPLE STRAND ROPE — BRAIDED

Diam of indi-vidual Ropes in.	Min Length (SL) of Sling ft-in.	Choker Hitch	Rated Capacities S/F 5				Slip-Thru Thimbles			Arc Thimbles Size No.	Lengths of Loops	
			Single-Leg Vertical	Basket Hitch			Size No.	W in.	L in.		Recommended L in.	min L in.
				30°	45°	60°						
1/8	1—6	0.71	0.95	1.6	1.3	0.95	W-2	2 1/8	4 1/4	8C	6	6
3/16	2—0	1.5	2.1	3.6	2.9	2.1	W-3	2 3/8	4 3/4	9C	10	6
1/4	2—6	2.3	3.1	5.3	4.3	3.1	W-4	3 1/2	6 1/4	10C	12	8
3/16	2—9	3.6	4.8	8.3	6.7	4.8	W-5	3 3/4	7 1/8	14C	16	8
3/8	3—6	5.1	6.8	12	9.7	6.8	W-5	3 3/4	7 1/4	16C	16	10
7/16	4—0	6.9	9.3	16	13	9.3	W-6	4 3/8	8 3/8	18C	18	12
1/2	4—6	9.0	12	21	17	12	W-7	5	9 1/2	20C	18	12
9/16	5—6	11	15	26	21	15	W-7	5	9 1/2	22C	24	14
5/8	6—6	14	19	32	26	19	W-8	6 1/4	11 3/4	24C	28	18
3/4	7—6	20	27	46	38	27	W-9	8	14 1/2	28C	30	20
7/8	8—9	27	36	62	51	36	W-10	8	15 1/2	32C	36	24
1	10—6	35	47	81	66	47	W-10	8	15 1/2	40C	48	30
1 1/8	12—6	47	63	109	89	63	W-11	9	18 1/2	48C	60	36
1 1/4	15—0	55	74	128	104	74	W-11	9	18 1/2	—	72	42
1 3/8	18—8	67	89	154	126	89	—	—	—	—	84	54

Width (W) of loop is approximately 1/2 the length (L). Larger sizes can be furnished upon request. Rated capacities of basket hitches are based on a minimum diameter of curvature at the point of load contact of 10 times the component rope diameter.
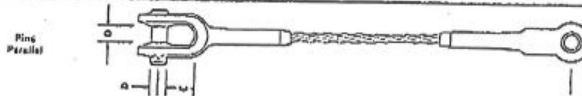
RATED CAPACITIES IN TONS OF 2,000 LB — BOOM PENDANT

Diam of Rope in.	Length (SL) of Sling ft-in.	Rated Capacities S/F 5			Open Swaged Socket				Closed Swaged Socket		
		Single-Part Vertical	Two Slings When Used		O in.	D in.	E in.	Weight lb	K in.	W in.	Weight lb
			30°	45°							
					6 x 19 Purple Strand IWRC Form-Set						
1/4	0—11	0.59	1.0	0.83	11/16	11/16	15/32	0.62	1/2	3/4	0.31
3/8	1—3	1.3	2.3	1.8	13/16	13/16	11 1/32	1.25	11/16	7/8	0.75
1/2	1—8	2.3	4.0	3.2	1	1	1 1/2	2.1	7/8	1 1/4	1.4
5/8	2—0	3.6	6.2	5.1	1 1/4	1 3/16	1 21/32	4.5	1 1/8	1 1/4	2.7
3/4	2—5	5.1	8.9	7.2	1 1/2	1 3/8	2 1/16	7.7	1 3/16	1 15/32	5.0
7/8	2—10	6.9	12	9.8	1 3/4	1 5/8	2 1/16	10.9	1 1/2	1 23/32	7.1
1	3—2	9.0	15	13	2	2	2 3/4	19.5	1 3/4	2 1/16	11
1 1/4	3—7	11	19	16	2 1/4	2 1/4	3 1/8	27.6	2	2 5/16	15.6
1 1/4	4—0	14	(24)	20	2 1/2	2 1/2	3 1/2	37	2 1/4	2 19/32	22.9
1 3/8	4—5	17	29	23	2 1/2	2 1/2	4	48	2 1/4	2 19/32	30
1 1/2	4—9	20	34	28	3	2 3/4	4 3/8	59.6	2 1/2	2 27/32	38
1 3/4	5—5	27	46	38	3 1/2	3 1/2	5	100	3	3 3/4	51
2	6—4	34	60	49	4	3 3/4	6 1/4	147	3 1/4	3 7/8	65

Purple Strand is manufactured by Bethlehem Steel Co. and is improved Plow steel quality.